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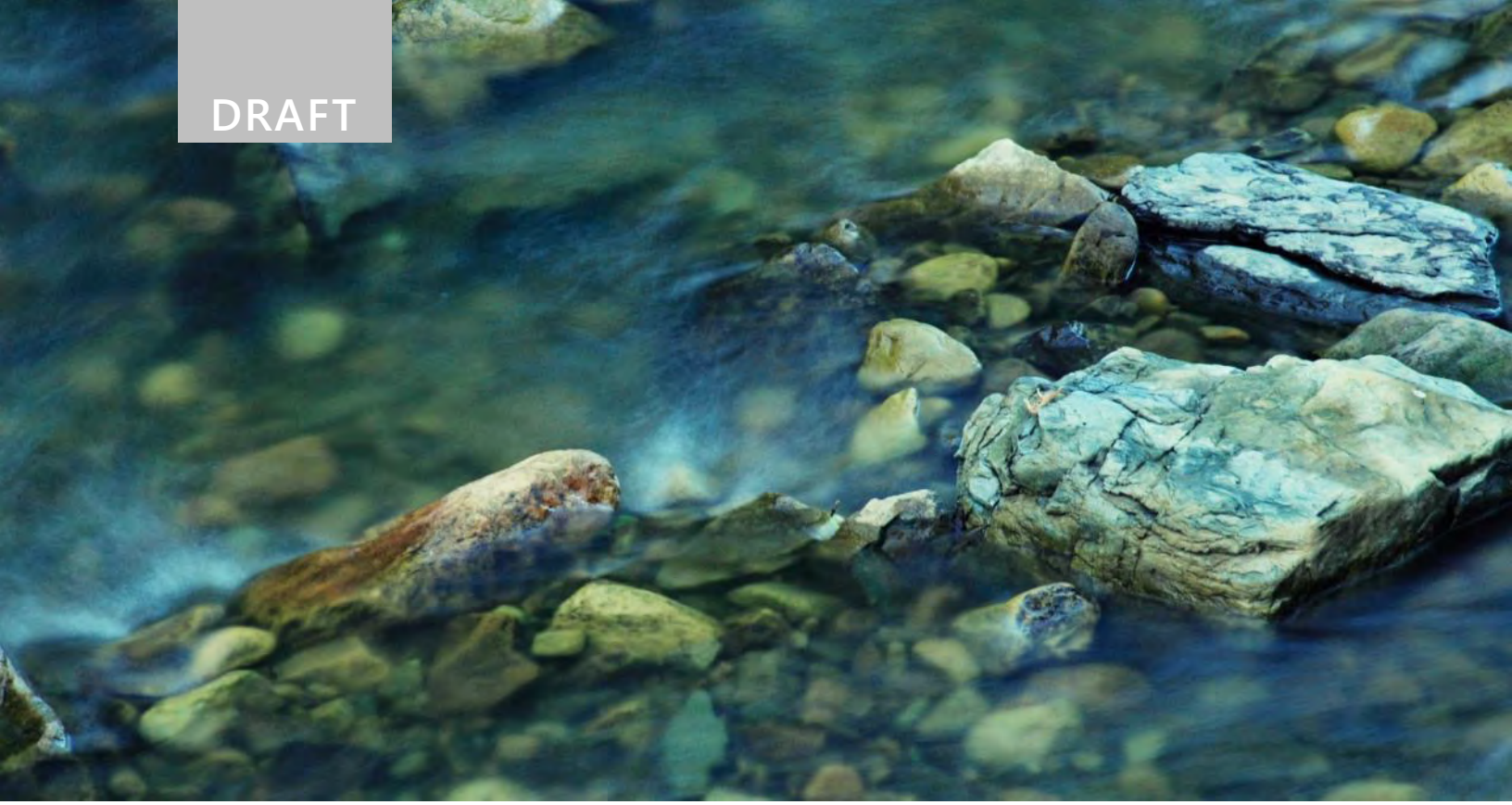

April 25, 2022
H&S Bosma Dairy Lagoon Nos. 1, 2, and 3
Administrative Order on Consent Docket No. SDWA-10-2013-0080

ANCHOR QEA

H&S Bosma Dairy
Lagoon Nos. 1, 2, and 3 Abandonment Plan

Prepared for H&S Bosma Dairy

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Lagoon Nos. 1, 2, and 3 Abandonment Plan

Prepared for
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Project Number: 210996-01.01

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ABBREVIATIONS

bgs	below ground surface
CAFO	Concentrated Animal Feeding Operation
Consent Order	Administrative Order on Consent SDWA-10-2013-0080
Dairy	H&S Bosma Dairy
EPA	U.S. Environmental Protection Agency
H:V	horizontal to vertical (ratio)
TKN	Total Kjeldahl nitrogen
mg/kg	milligrams per kilogram
Plan	Lagoon Abandonment Plan
SVID	Sunnyside Valley Irrigation District
WA NRCS	Washington State Natural Resources Conservation Service

1 Introduction

This Lagoon Abandonment Plan (Plan) was prepared by Anchor QEA, LLC, on behalf of H&S Bosma Dairy (the Dairy) as required by the U.S. Environmental Protection Agency (EPA) Region 10 Administrative Order on Consent SDWA-10-2013-0080 (Consent Order).

The Dairy has implemented a program of lagoon consolidation and abandonments to reduce the number and footprint of its lagoon system. As part of this ongoing work, the Dairy is proposing to abandon Lagoon Nos. 1, 2, and 3 (Figures 1 and 2) located in the southern portion of the Dairy.

EPA specified in EPA Letter 284 (April 18, 2022) that sampling data are required prior to finalizing the decision on how to abandon the lagoons and how to address the presence of nutrient-rich soils that are or may be present beneath the lagoons.

This Plan describes the plan for completing sampling beneath Lagoon Nos. 1, 2, and 3 in support of those future decisions. The sampling includes follow-up testing for Lagoon No. 3 and tiered sampling for Lagoon Nos. 1 and 2 to be completed prior to August 1, 2022.

Following sampling, the data will be transmitted to EPA for review. This Plan will then be updated and submitted to EPA for review by September 1, 2022. The final abandonment plan will address the requirements of the 2016 *Final Modified Lagoon Work Plan* (Anchor QEA 2016) as approved by EPA. It will also meet or exceed exceeds the requirements of Washington State Natural Resources Conservation Service (WA NRCS) *Conservation Practice Standard 360 – Waste Facility Closure* (WA NRCS 2013a) and demonstrate compliance with nutrient management requirements of WA NRCS *Conservation Practice Standard No. 590 – Nutrient Management* (WA NRCS 2013b).

The remaining sections of this Plan are organized as follows:

- **Section 2 – Existing Conditions.** This section reviews the current conditions of the Dairy and presents the approximate dimensions and current status of Lagoon Nos. 1, 2, and 3.
- **Section 3 – Abandonment Procedures.** This section discusses the removal of liquids and organic solids and soil confirmation testing procedures.
- **Section 4 –Schedule.** This section outlines the abandonment timeline.
- **Section 5 – References.** This section provides references for the materials cited in this Plan.

2 Existing Conditions

The Dairy is located at 5860 East Zillah Drive Road in Granger, Washington. Figure 1 shows the location of Lagoon Nos. 1, 2, and 3. Estimated dimensions and capacities of the existing lagoons are provided in Table 1.

2.1 Lagoon History

The three lagoons are located in a natural ravine located between Kirst Road to the north and the Sunnyside Valley Irrigation District (SVID) canal located to the south. In the distant past this drainage contained an ephemeral stream. But this natural drainage was modified over the last century by the development of irrigation infrastructure, site and community development features, and other agricultural changes to the surrounding lands.

Prior to the 1990s, the SVID operated an irrigation return water canal in the natural depression that conveyed irrigation return water from flood irrigation systems in the area back to the main SVID canal. That open ditch was piped (24-inch-diameter PVC pipe)and buried by SVID in the early 1990s. The approximate location of the current SVID irrigation return line is shown on Figure 2.

Impoundments at the location of Lagoon Nos. 1 and 2 were constructed first as tailwater ponds prior to the mid-1990s. At that time most of the fields in the vicinity were irrigated by flood irrigation. By 2005 the adjacent field had been modified to use modern pivot irrigation, and the three lagoons had been excavated to approximately their current dimensions. Copies of Google Earth images from 1995 and 2005 showing these changes are attached in Appendix A.

Since their conversion to full-service manure lagoons, Lagoon Nos. 1, 2, and 3 have been used to store stormwater runoff and manure waste generated from Dairy operations. Liquids collected within the lagoons were stored and then pumped to application fields or to the existing lagoon system.

For the purposes of the Consent Order, the term “lagoon” includes animal waste lagoons and animal waste management or storage ponds. Lagoon Nos. 1, 2, and 3 have historically served as animal waste storage ponds that contained manure, runoff from land areas contaminated with animal waste, and waste liquids from manure processing and other process operations.

2.2 Lagoon Status

Between 2016 and 2021 the Dairy has undertaken a program to optimize its lagoon network. This has included the consolidation, lining, and in some cases expansion of the most appropriate lagoons (i.e., those with the best operational locations and those located in the most protective soil types). Smaller, inefficient, and poorly located lagoons have been abandoned. The Dairy has also conducted updates to its operations, eliminating one of its milking parlors and updating its manure and process

water management. These changes have reduced the Dairy's generation of manure and process-area liquids.

The net effect of the Dairy's lagoon optimization program has been to reduce its needed lagoon count from 22 to 7. The Dairy's current lagoon network includes an operational capacity of 32.8 million gallons and an emergency capacity of 38.9 million gallons (Appendix B). The Dairy's actual manure and stormwater production volumes have ranged from 26.0 to 30.9 million gallons between 2019 and 2021. The Dairy includes a conservative 37-million-gallon estimate of manure and stormwater production in its current Dairy Nutrient Management Plan (DNMP).

Under the DNMP the Dairy requires a minimum winter storage capacity exceeding 4 months. Based on the conservative DNMP-based manure and stormwater production estimate, the Dairy's current winter storage capacity is more than 10.6 months without Lagoon Nos. 1, 2, and 3. Using emergency volumes, the lagoon capacity is 12.7 months.

Table 1 summarizes the current dimensions and capacities of Lagoon Nos. 1, 2, and 3. The Dairy has proposed to abandon these three lagoons because they are not needed for manure or stormwater management capacity and because they are located in a higher-risk geologic area with sandy soils and relatively shallow (30 to 35 feet below ground surface [bgs]) groundwater.

Table 1
Lagoon Nos. 1, 2, and 3 Approximate Dimensions and Capacity

Lagoon	Length (feet)	Width (feet)	Depth (feet)	Operating Capacity (million gallons)	Capacity (acre-feet)	Approximate Interior Side Slope
1	950	210	10	8.6	26.4	2H:1V
2	450	100	10	1.8	5.5	3H:1V
3	580	120	10	1.7	5.2	3H:1V

The current status of each lagoon is as follows:

- Lagoon No. 3 was removed from use in early fall 2021 and was emptied of manure and liquids. Soil sampling data were collected from the base and sidewalls of the lagoon to depths of 10 feet bgs in November 2021 (Section 2.3 and Table 2). An abandonment plan was submitted to EPA for review in January 2022 (Anchor QEA 2022). EPA subsequently determined that additional data were required prior to proceeding with finalization of decisions regarding the future lining or abandonment of this lagoon. In the meantime the Dairy has implemented a daily visual monitoring program to ensure that the lagoon remains dry (Photographs 1, 2, and 3). It has also installed two soil moisture sensors in the bottom of the lagoon (Photograph 3) to provide real-time monitoring of soil moisture levels at depths of

1 foot, 3 feet, and 5 feet bgs. These soil moisture sensors are actively maintained by Agrimanagement, Inc.

- Lagoon No. 2 has been taken out of service, and liquid manure has been removed. Lagoon conditions as of April 4, 2022, are shown in Photograph 4. Residual solid manure will be removed prior to June 1, 2021. Soil sampling is currently scheduled for the first 2 weeks of June. Lagoon No. 2 has been added to the Dairy's daily visual monitoring program along with Lagoon No. 3.
- Lagoon No. 3 has been taken out of service but still contains liquid and solid manure (Photograph 5). The liquid manure will be removed during May and June 2022. Residual solid manure will be removed in June and early July 2022. At that time the lagoon will be added to the Dairy's daily visual monitoring program along with Lagoon No. 3. Soil sampling is proposed for completion in July prior to August 1.

Photograph 1
Condition of Lagoon No. 3 in December 2021 Following Manure and Liquids Removal

Photograph 2
Condition of Lagoon No. 3 as of April 4, 2022

Photograph 3
Condition of Lagoon No. 3 Soil Moisture Sensors as Installed

Photograph 4
Lagoon No. 2 as of April 4, 2022, After Liquids Removal

Photograph 5
Lagoon No. 1 as of April 4, 2022

2.3 Lagoon No. 3 Soil Sampling Data

Following removal of the manure, soil testing was conducted within Lagoon No. 3 to document the ammonia and nitrate concentrations in the subsurface soil. Confirmation testing was conducted at six locations within Lagoon No. 3, including one sample from the lower portion of each sidewall and two samples from the lagoon bottom. Figure 2 shows the actual sampling locations.

Soil samples were analyzed in a single phase. Results of testing are summarized in Table 2. Results of soil testing demonstrated that ammonia and/or nitrate concentrations in excess of the target level (45 milligrams nitrogen per kilogram [mg N/kg]) were present at depths between 3 and at least 10 feet bgs, with an average depth of just over 6 feet. Depths exceeding the target level were greatest for the east and west sidewalls (sample stations SO-2 and SO-3), both of which exceeded the target level at the deepest depths (10 feet bgs) sampled. These locations will be resampled at deeper depths as described in Section 3.2.

Table 2
Results of Initial Soil Testing at Lagoon 3

Station ID	Depth Range (inches)	Nitrate-N (mg N/kg)	Ammonia-N (mg N/kg)	Available N (mg N/kg)	Exceeds 45 mg N/kg?
S-01 (North Sidewall)	**0–12**	147.7	1.7	**149.4**	**Yes**
	12–24	89.5	ND (u)	**89.5**	**Yes**
	24–36	47.7	2.6	**50.3**	**Yes**
	36–48	93.8	3.1	**96.9**	**Yes**
	48–60	18.3	3.6	21.9	No
	60–72	17.3	2.9	20.2	No
	72–84	14.2	3.1	17.3	No
	84–96	28.8	2.6	31.4	No
	96–108	20.3	3.5	23.8	No
	108–120	30.4	3.6	34	No
S-02 (West Sidewall)	**0–12**	26.8	97.5	**124.3**	**Yes**
	12–24	1.0	30.8	31.8	No
	24–36	1.0	23.1	24.1	No
	36–48	1.8	25.0	26.8	No
	48–60	28.5	25.2	**53.7**	**Yes**
	60–72	39.9	1.9	41.8	No
	72–84	51.6	3.3	**54.9**	**Yes**
	84–96	67.0	8.5	**75.5**	**Yes**
	96–108	41.7	ND (u)	41.7	No
	108–120	45.6	7.2	**52.8**	**Yes**

Station ID	Depth Range (inches)	Nitrate-N (mg N/kg)	Ammonia-N (mg N/kg)	Available N (mg N/kg)	Exceeds 45 mg N/kg?
S-03 (East Sidewall)	**0–12**	83.3	ND (u)	**83.3**	**Yes**
	12–24	188.2	ND (u)	**188.2**	**Yes**
	24–36	103.1	ND (u)	**103.1**	**Yes**
	36–48	85.5	ND (u)	**85.5**	**Yes**
	48–60	131.3	4.2	**135.5**	**Yes**
	60–72	56.6	ND (u)	**56.6**	**Yes**
	72–84	44.6	2.3	**46.9**	**Yes**
	84–96	69.5	ND (u)	**69.5**	**Yes**
	96–108	76.7	1.8	**78.5**	**Yes**
	108–120	113.1	2.7	**115.8**	**Yes**
S-04 (South Sidewall)	**0–12**	5.9	67.9	**73.8**	**Yes**
	12–24	ND (u)	81.7	**81.7**	**Yes**
	24–36	ND (u)	61.6	**61.6**	**Yes**
	36–48	2.9	10.7	13.6	No
	48–60	21	21.6	42.6	No
	60–72	1.8	6.0	7.8	No
	72–84	6.6	5.0	11.6	No
	84–96	6.8	6.1	12.9	No
	96–108	3.4	4.5	7.9	No
	108–120	6.9	2.4	9.3	No
B-N (North Bottom Sample)	**0–12**	23.7	251.3	**275**	**Yes**
	12–24	1.9	139.7	**141.6**	**Yes**
	24–36	15.4	128.6	**144**	**Yes**
	36–48	0.8	208	**208.8**	**Yes**
	48–60	ND (u)	20.5	20.5	No
	60–72	4.8	18.5	23.3	No
	72–84	1.1	32.6	33.7	No
	84–96	ND (u)	14.3	14.3	No
	96–108	1.4	10.1	11.5	No
	108–120	0.7	8.2	8.9	No
B-S (South Bottom Sample)	**0–12**	176.8	109.5	**286.3**	**Yes**
	12–24	6.0	92.8	**98.8**	**Yes**
	24–36	24.4	6.6	**31.0**	**Yes**
	36–48	11.2	65.2	**76.4**	**Yes**
	48–60	11.8	118.7	**130.5**	**Yes**
	60–72	45.6	10.3	**55.9**	**Yes**
	72–84	19.8	5.7	25.5	No

Station ID	Depth Range (inches)	Nitrate-N (mg N/kg)	Ammonia-N (mg N/kg)	Available N (mg N/kg)	Exceeds 45 mg N/kg?
	84–96	9.8	5.6	15.4	No
	96–108	21.0	7.8	28.8	No
	108–120	15.4	10.1	25.5	No

Notes:
Bolded available nitrogen values exceed the target value of 45 mg N/kg.
ND: not detected

3 Abandonment Procedures

This section describes the overall lagoon abandonment procedures, including the following:

- Liquids and organic solids removal
- Soil nutrient testing
- Abandonment plan resubmittal
- Final abandonment procedures
- Completion reporting

Further discussion with EPA is required to finalize decisions regarding lagoon abandonment and the management of soil nutrient levels. Therefore, the section on final abandonment procedures (Section 3.3) remains preliminary at this time. This section will be updated in the future resubmittal of this Plan following completion of soil sampling.

3.1 Liquids and Organic Solids Removal

Prior to sampling, Lagoon Nos. 1 and 2 will have liquids, organic solids, and vegetation (if present) removed. Liquids contained within the lagoon will be transferred to an in-service, lined lagoon or agronomically applied during a manure application.

After liquid removal, organic solids will be removed and placed in the composting area. Solids will be removed down to the current lagoon soil foundation material.

Expected completion dates for liquid and solids removal are as follows:

- Lagoon No. 3: Complete (completed November of 2021)
- Lagoon No. 2: Liquids removal complete (removed March 2022); solids to be removed by July 1, 2022.
- Lagoon No. 1: Liquids to be removed by June 15, 2022; solids to be removed by July 1, 2022

3.2 Soil Nutrient Testing

Following removal of liquids, organic solids, and vegetation, soil testing will be conducted at the Lagoon Nos. 1 and 2 sampling locations shown in Figure 2. Consistent with the 2016 *Modified Lagoon Work Plan* (Anchor QEA 2016), the clean soil horizon is defined as soils with the sum of ammonia-nitrogen and nitrate-nitrogen equal to or less than 45 milligrams per kilogram (mg/kg).

Soil nutrient testing will include the six locations in Lagoon Nos. 2 and nine locations within Lagoon No. 1. As shown in Figure 2, the sampling locations include samples from the lower portion of each sidewall and multiple samples from the lagoon bottoms. Sampling will also be performed at the two sampling locations (SO-2 and SO-3 on the east and west sidewalls) that exhibited available nitrogen levels in excess of 45 mg N/kg at 10 feet bgs during previous soil testing (Table 2).

Tier 1 testing of Lagoons 1 and 2 will use a backhoe to quantify available nitrogen concentrations (ammonia-nitrogen and nitrate-nitrogen) in soils at depths between 0 and 10 feet bgs. Tier 2 testing (as needed) will use a Geoprobe or auger drilling rig to sample depths 11 feet or deeper as required to reach concentrations below 45 mg N/kg (measured as the sum of ammonia and nitrate nitrogen).

Soils will also be archived and tested selectively for total Kjeldahl nitrogen (TKN; measures the sum of ammonia and organic nitrogen) so that the quantity of organic nitrogen present in each soil horizon can be estimated (organic nitrogen is estimated by subtracting the ammonia nitrogen value from the TKN value). TKN analysis will be performed on the soils with the highest three available nitrogen concentrations and on the deepest three intervals tested for available nitrogen in each sampling location.

Soil sampling will be conducted from the interior of the lagoons using the following methods:

- Tier 1 Sampling:
  - A backhoe will be used to collect soil samples representative of each 12-inch interval of the soil column to depths of 10 feet bgs. The backhoe method can be implemented earlier than geoprobe sampling, providing more rapid data acquisition.
  - Initial soil samples will be collected from a depth interval of 0 to 12 inches bgs.
  - Subsequent samples will be collected at each 1-foot interval to a depth of 10 feet.
  - Sampling personnel will record the location and depth of each soil sample to the nearest inch.
  - After samples have been collected, the samples will be placed in appropriate containers, and a custody seal bearing the sampler's name or initials and date will also be placed on the container.
  - All Tier 1 samples will be analyzed for ammonia-nitrogen, nitrate-nitrogen, and TKN.
  - Each test pit will be logged by a licensed geologist or professional engineer, and a test pit log will be prepared for inclusion in the revised abandonment plan.
- Tier 2 Sampling: Tier 2 sampling will be performed at each location where the target 45 mg N/kg concentration has not been reached during Tier 1 testing.
  - A geoprobe or soil auger rig will be used to collect soil samples representative of each 12-inch interval of the soil column below depths of 10 feet bgs. A standard or limited access geoprobe or auger rig will be utilized as appropriate to field conditions following completion of Tier 1 testing.
  - Initial soil samples will be collected from a depth interval of 10 to 11 feet bgs.
  - Subsequent samples will be collected at each 1-foot interval to the water table (estimated depth 35 feet bgs).
  - Sampling personnel will record the location and depth of each soil sample to the nearest inch.

- After samples have been collected, the samples will be placed in appropriate containers, and a custody seal bearing the sampler's name or initials and date will also be placed on the container.
- Each soil boring will be logged by a licensed geologist or professional engineer, and a boring log will be prepared for inclusion in the revised abandonment plan.
- Tier 2 samples will be analyzed for ammonia, nitrate, and TKN in a phased manner as described below.

Laboratory analysis of the soil samples will be performed by SoilTest Farm Consultants, Inc., a State of Washington-certified analytical laboratory and a North American Proficiency Testing-accredited laboratory located at 2925 Driggs Drive, Moses Lake, Washington. Sample management, packing, shipment, analytical testing, quality assurance/quality control, and data validation protocols will be consistent with those defined in the *Dairy Facility Application Field Management Plan* (Anchor QEA 2018) as follows:

- Ammonium (as nitrogen) by Western Coordinating Committee S-3.50
- Nitrate (as nitrogen) by Western Coordinating Committee S-3.10
- TKN by Western Coordinating Committee S-8.10

Archived samples will be analyzed from deeper depths until a clean soil horizon is reached. All Tier 1 samples will be analyzed initially for available nitrogen. Tier 2 soil samples will be analyzed in phases, starting with the upper 5-foot intervals (i.e., 10–11, 11–12, 12–13, 13–14, and 14–15). Tier 2 analyses for available nitrogen will continue as required with analysis of each subsequent set of 5-foot intervals until the target available nitrogen concentration has been met or the water table has been reached.

Soil sampling data will be provided to EPA for each lagoon in a Transmittal Memorandum within 10 days of receipt and validation of the data. Data for each lagoon are to be transmitted as they are completed (i.e., three transmittals are expected). All testing must be completed by August 1, 2022, with the data transmitted to EPA by August 10, 2022.

3.3 Abandonment Plan Resubmittal

This Plan is to be resubmitted to EPA by September 1, 2022. That plan will include each of the following:

- Copies of all soil nutrient data as received from the laboratory and copies of associated data validation reports.
- A written proposal for final lagoon abandonment, including management of soil nitrogen exceeding the target level.

- An updated plan-view contour map of the lagoons, including proposed interim (during) and final (after abandonment) grading contours. Control points shall be added by a licensed surveyor so that the existing drone survey can be mapped with confirmed elevation contours.
- Copies of all test pit and boring logs and a cross section beneath the lagoons on a north-south axis, including elevation, the vadose zone soil types, and the water table. That section shall incorporate data from the test pits and borings, along with existing data available from other project investigations as shown in the 2018 *Groundwater Monitoring Report*.
- A proposed schedule for completion of final abandonment, including expected time frames for addressing soil nitrogen levels.

3.4 Final Abandonment Procedures

Final abandonment procedures have not yet been approved by EPA for Lagoon Nos. 1, 2, or 3. The Dairy has proposed to treat excess nitrogen by in situ soil treatment by cropping the soils with deep-rooted crops as described in Section 3.4.1. However, EPA has stated that in situ crop remediation may not be effective, depending on how deep the soil nutrient levels extend. EPA has reserved the right to require additional remedies to the extent that deep soil nitrogen levels cannot be addressed by the cropping method.

3.4.1 In Situ Cropping Proposal

This section describes the Dairy's current proposal for how nutrients can be extracted from the soils beneath the lagoon using in situ treatment. Soil treatment will be performed agronomically using a combined forage crop including alfalfa and chicory. Alfalfa and chicory were selected to maximize nitrogen extraction rates, particularly from deep soil horizons, and details are provided as follows:

- **Alfalfa:** Alfalfa is a perennial forage crop that is well suited to deep rooting and high dry matter production (resulting in high nitrogen extraction rates). Research has shown that alfalfa can extract nutrients up to a depth of 120 centimeters (approximately 4 feet) within the first year after establishment. Roots can continue to push deeper through Years 2–4 until extraction has been observed up to a depth of 270 centimeters (over 8 feet) (Entz et al. 2001). In addition to crop age, soil and irrigation conditions can affect the depth of rooting. Even though alfalfa can obtain nitrogen for growth via symbiotic nitrogen fixation, it is also very effective in removing inorganic nitrogen from the soil (Russelle 1991). Research shows that alfalfa is an excellent crop for extraction of inorganic nitrogen from soil (Russelle et al. 2001). At a mono-crop yield of 9 tons/acre per year, alfalfa can typically extract nitrogen at a rate of up to 585 pounds nitrogen/acre per year.
- **Chicory:** Chicory is a deep-rooted, broad-leafed perennial that is very drought tolerant and hardy and responds well to higher levels of nitrogen within the soil. It can send roots over 3 meters (over 9 feet) deep within the first 3 months of growth and extend to 4 meters deep (over 13 feet) by Year 2 (Rasmussen 2020). At a mono-crop yield of 5.5 tons/acre per year,

chicory can typically extract nitrogen at a rate of up to 185 pounds nitrogen/acre per year (Ditsch and Sears 2007).

As a mixed crop, Agrimanagement expects that the nitrogen extraction rate will likely be between 525 and 585 pounds per year. The mixed crop can be managed and harvested together efficiently. The mixing of the two crops is intended not to drive up overall nitrogen extraction, but rather to optimize the following: 1) the rate of extraction throughout the lagoon area; and 2) the removal of nitrogen from deeper soil horizons. The mixed crop can be expected to recover available nitrogen from depths at and below 10 feet. Removal rates can be expected to be highest in the upper soil horizon. Deeper soil extraction will likely increase over time as shallow soil reservoirs are exhausted.

Advantages of the soil treatment approach in comparison to other methods (e.g., soil excavation, export and backfill with clean soil) include the following:

- **Ability to treat all lagoon areas:** The western portion of Lagoon Nos. 1, 2, and 3 are located adjacent to SVID irrigation infrastructure located within an SVID easement. Excavation of nutrient-rich soils would be more difficult in this area, requiring temporary shoring methods. In situ treatment does not have this limitation.
- **Soil conservation:** The in situ treatment approach will not damage the food production value of the existing soils in comparison to an excavation approach and will not require import of clean soil.
- **Lower fuel consumption:** Overall fuel consumption (and associated production of greenhouse gas emissions) will be much lower for the in situ treatment approach in comparison to an excavation and backfill approach.
- **Incidental treatment of soils below the treatment target:** Though not required to complete lagoon abandonment, the in situ treatment approach will be applied throughout the Lagoon Nos. 1, 2, and 3 footprints with the same deep-penetrating crop mix. This means that nutrient extraction will occur in all lagoon areas, even those that currently are below treatment objectives.

The treatment crop will be planted throughout the former lagoon footprints. Agrimanagement will install irrigation sensors within the former lagoon bottom to help optimize both yields and deep root penetration while minimizing potential downward flux of nitrogen through soil leaching. Deep root penetration is achieved best by establishing a healthy crop and then restricting its moisture to drive roots deeper in a search for water. This restriction must not, however, be excessive or nutrient extraction rates will fall off.

The irrigation sensors will be consistent with those used to monitor shallow soil moisture levels in the existing nutrient application fields at the Dairy. However, the soil sensors will be installed at the following adjusted depths: 1 foot, 3 feet, and 5 feet bgs.

Irrigation will be provided as necessary to support optimal crop growth and root penetration. The irrigation will be provided using solid sets or equivalent. Irrigation will follow irrigation needs estimates provided by Agrimanagement. Irrigation records will be maintained to document the dates and duration of irrigation, and these will be summarized in interim annual reports and in the completion report.

Throughout the duration of treatment the Dairy will maintain run-on controls to prevent irrigation water, stormwater or snow melt from accumulating in the abandoned lagoons. A tailwater pond is already located in the adjacent agricultural field to capture stormwater and snow melt from that area. The lagoons are otherwise isolated from run-on influences by berms roadways and ditches.

During treatment, the forage mix will be harvested periodically consistent with standard agronomic practices to remove the extracted nutrients from the treatment area. Treatment is expected to require multiple years to complete. Initial Anchor QEA and Agrimanagement treatment estimates were between 3 and 4 years for Lagoon No. 3. Treatment time estimates will be developed for Lagoon Nos. 1 and 2 and updated for Lagoon No. 3 following receipt of updated soil testing data.

During each year of the treatment period, an interim treatment report will be submitted to EPA following each calendar year. The report will summarize the following:

- Results of soil moisture monitoring
- Crop yield achieved during the calendar year harvests
- Estimated nitrogen extraction rates
- Results of soil confirmation testing (Year 2 only)
- Recommended final treatment duration (Year 2 only)

At the end of an initial 2-year treatment period, soil confirmation testing will be completed using the same locations, depths, and procedures as described in Section 3.2. will be repeated adjacent to each of the original testing locations. Testing will document soil ammonia-nitrogen and nitrate-nitrogen to depths of 10 feet or to the base of the contamination at each location and will be used to update the expected treatment duration.

If testing confirms that the target nitrogen concentrations have been reached after 2 years, then treatment will be considered complete. If nitrogen concentrations remain in excess of the treatment target, then treatment will be conducted for an additional 1- or 2-year period. The duration will be estimated based on observed nitrogen extraction rates and soil testing data.

Final confirmation testing will be implemented at the end of the treatment period. Final confirmation testing will be completed using the same locations, depths, and procedures as described in Section 3.2. Sampling shall be repeated adjacent to each of the six initial testing locations. Testing will document soil ammonia-nitrogen and nitrate-nitrogen to depths of 10 feet or to the base of the

elevated nitrogen readings at each location. These data will be used to update the expected treatment duration.

3.4.2 Alternative Soil Management Methods

It is possible that deep soil nitrogen levels may extend in some locations beyond the depths treatable through agronomic extraction methods. Methods to address such deep soil nitrogen will be addressed during the resubmittal of this plan (i.e., after all nutrient testing data are available).

3.5 Completion Report

Following completion of soil treatment and final confirmation testing, Anchor QEA will prepare and submit a completion report.

To the extent that soil treatment is achieved by cropping, that report will include the following information:

- A short narrative describing the lagoon abandonment work completed, including a discussion of crop yields and nutrient extraction accomplished during the treatment period
- Copies of construction photographs showing the lagoon after emptying and during soil treatment
- Results of all soil testing
- Results of soil moisture monitoring
- Statement that the closure followed WA NRCS *Conservation Practice Standard 360 – Waste Facility Closure* (WA NRCS 2013a) practices
- Documentation of site conditions following soil treatment

To the extent that alternative methods are used for lagoon abandonment, the contents of the completion report will be as specified in the final approved abandonment plan.

4 Schedule

The proposed schedule for lagoon abandonment includes the following:

- **Lagoon No. 3 Tier 2 Testing:** Complete field activities within 14 days of written approval of this Plan.
- **Lagoon Nos. 1 and 2 Soil Testing:** Complete Tier 1 and Tier 2 soil testing by August 1, 2022, and transmit the data to EPA by August 10, 2022.
- **Revised Abandonment Plan:** This Plan shall be revised and resubmitted to EPA by September 1, 2022. Consultation with EPA between August 1 and September 1, 2022, will be required to coordinate final abandonment planning.
- **Crop Planting:** To the extent that cropping is approved by EPA for treatment of some or all of the elevated soil nitrogen and the plan is approved by October 1, 2022, the crop shall be planted in the treatment area prior to October 15, 2022.
- **Final Abandonment Schedule:** The final abandonment schedule shall be as stated in the final abandonment plan as approved by EPA.

5 References

Anchor QEA (Anchor QEA, LLC), 2016. *Final Modified Lagoon Work Plan*. Prepared for Liberty Dairy, LLC/H&S Bosma Dairy. December 2016.

Anchor QEA, 2018. *Dairy Facility Application Field Management Plan*. Prepared for Cow Palace, LLC, George DeRuyter & Son Dairy, LLC/D&A Dairy, LLC/George & Margaret, LLC, and Liberty Dairy, LLC/H&S Bosma Dairy. February 2018.

Anchor QEA, 2021. *H&S Bosma Dairy Lagoon Nos. 1, 2 and 3 Abandonment Plan*. Prepared for H&S Bosma Dairy. May 27, 2021.

Anchor QEA, 2022. *H&S Bosma Dairy Lagoon 3 Abandonment Plan*. Prepared for H&S Bosma Dairy. January 18, 2022.

Ecology (Washington State Department of Ecology), 2017. Concentrated Animal Feeding Operation. National Pollutant Discharge Elimination System and State Waste Discharge General Permit. Issued: January 18, 2017.

WA NRCS (Washington State Natural Resources Conservation Service), 2013a. *Conservation Practice Standard No. 360 – Waste Facility Closure*. January 2013.

WA NRCS, 2013b. *Conservation Practice Standard No. 590 – Nutrient Management*. December 2013.

Figures

SOURCE: Aerial from Microsoft (Bing) 4/11/2018
HORIZONTAL DATUM: Washington State Plane South, NAD83, U.S. ft

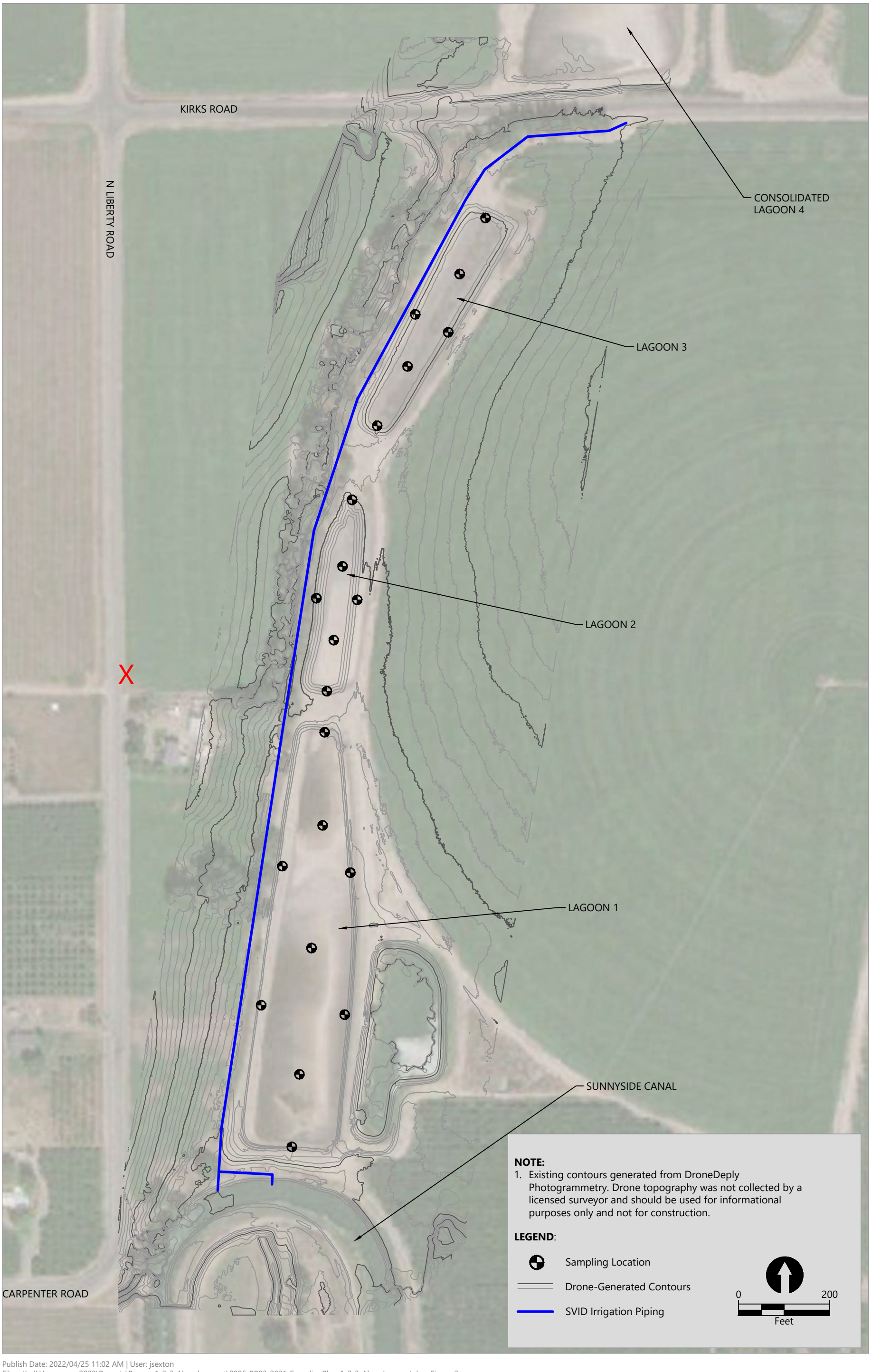
0 600
Feet

Publish Date: 2021/05/24 10:04 AM | User: jsexton
Filepath: K:\Projects\0996-Perkins Coie\Yakima Dairies Project\Reports\Bosma_1_2_3\0996-RP-001-Bosma.dwg Bosma-1_2_3

ANCHOR QEA

Figure 1
H&S Bosma Dairy Lagoon Map

Lagoon No.'s 1, 2 and 3 Abandonment Plan
H&S Bosma Dairy



Publish Date: 2022/04/25 11:02 AM | User: jsexton
Filepath: K:\Lagoons - 2022\Reports\Bosma_1-2-3_Abandonment\0996-RP03-2021-SamplingPlan-1_2_3_Abandonment.dwg Figure 2

ANCHOR QEA

Figure 2
Proposed Sampling Locations and Grading

Lagoon Nos. 1, 2, and 3 Abandonment Plan
H&S Bosma Dairy

Appendix A
Historical Aerial Photographs


Google Earth
1996 Photo
Legend
Kirks Rd
Kirks Rd
West Lateral
N Liberty Rd
N Arms Rd
Carpenter Rd
W Knowles Rd
Ditch Bank Rd
Google Earth
Image U.S. Geological Survey
N
1000 ft


Google Earth
2005 Photo
Legend
Kirks Rd
West Lateral
N Liberty Rd
N Arms Rd
W Knowles Rd
Knowles Rd
N
1000 ft
Google Earth

Appendix B
H&S Bosma Lagoon Capacity Evaluation

LIBERTY/BOSMA LAGOON CAPACITY ESTIMATION

DNMP Estimated Manure Production: 37 MG/yr

Annual Liquid Manure Production (Actuals)

2019 29.4 MG/yr
2020 26.0 MG/yr
2021 30.9 MG/yr

Required Minimum Storage: 4 month capacity

Available Capacity	**DNMP Estimate (mo.)** [5]	**Max of 2019-2021 (mo.)** [4]
At Operating Volumes:	10.6	12.6
At Maximum Volumes:	12.7	15.1

	Estimates of Initial Operating Volume (Prior to Lining and Abandonment)			**Estimated Volumes Following Lining/Abandonment**	
Lagoon ID	Column 1 Initial Vol Estimate (2016 Lagoon Work Plan) [1]	Column 2 Annual Report Estimates (2021 Annual Report) [2]	Column 3 **Updated Operating Estimate** [3] (Design & Completion Reports)	Column 4 Operational Volume (Completion Reports)	Column 5 Max Volume (Completion Reports)
Total Capacity (MG)	**56.2**	**55.5**	**39.2**	**32.8**	**38.9**
Manure Storage (MG)	**52.6**	**52.0**	**35.7**	**32.77**	**38.85**
1	14.4	14.4	8.6	0	0
2	2.6	2.6	1.8	0	0
3	4.3	4.3	1.7	0	0
4a	5.6	12.6	8.9	13.1	14.9
4b	4.1				
5	2.9				
6	3.8	2.45	2.3	2.74	3.48
7	2.5	4.5	1.1	3.94	4.5
12	0.7		0.6		
10	1	2.00	0.7	2.15	2.71
11	0.5		0.5		
13	0.7		0.5		
14	5.3	5.3	5.2	5.8	6.9
15	1.5	2.6	1.5	2.65	3.28
16	0.6		0.6		
17	0.5		0.5		
RWP	1.6	1.2	1.2	2.39	3.08
Compost-Area SW [4]	**3.6**	**3.5**	**3.5**	**0**	**0**
8	0.6	0.6	0.6	Abandoned	Abandoned
9	0.3	0.3	0.3	Abandoned	Abandoned
18	1.9	1.9	1.9	Abandoned	Abandoned
19	0.6	0.4	0.4	Abandoned	Abandoned
20	0.2	0.3	0.3	Abandoned	Abandoned

Notes:

MG: Million gallons

Lagoon capacities are shown in units of million gallons (MG). Manure production values are listed in units of million gallons per year (MG/yr).

1. The 2016 Lagoon Work Plan volume estimates were not based on surveys. They were based on preliminary measurements conducted by Inland Earth Sciences and have been shown to contain significant discrepancies from actual volumes. Improved estimates were later developed as part of the lining and abandonment process.

2. In most cases the initial volume estimates remained unchanged from those presented in the 2016 Lagoon Work Plan (this was requested by EPA for consistency with initial estimates). The volume estimate for Lagoons 7 and 12 is in error (the value shown is the post-construction maximum volume not the pre-construction volumes).

3. The updated volume estimates in Column 3 are based on survey data collected during the lining and abandonment process. These estimates include significant updates from the 2016 Work Plan Estimates.

4. The compost-area stormwater lagoons were never fully utilized. Their utility has been replaced by new stormwater management provisions. Excess storage capacity is available in the lagoon system if needed for trucked/pumped water from the compost-area stormwater systems.

5. The Dairy Nutrient Management Plan includes conservative literature-based estimates of manure production and estimates of stormwater production. These values are higher than actual manure and stormwater generation rates at the Dairy.